How does climate exacerbate root causes of conflict? Mapping the science around climate security

Objective of the analysis and research questions

While climate science has been a well-established field for many decades, the turn of the century has seen a significant growth in global interdisciplinary research on climate change and the impacts on various social, economic, and ecologic dimensions. As climate change-induced stresses increasingly affect global efforts to achieve sustainable peace, this analysis aims to provide a synthesis of the global scientific landscape regarding climate security. It also seeks produce a data-driven set of impact pathways to support the analysis carried out for the seven African countries in focus in the Climate Security Observatory.

The main research questions we address are:

1. How is global climate research addressing the dynamics between climate, socio-economic factors, and conflict?
2. How are the countries in focus for the Climate Security Observatory represented in this literature?

A machine-learning approach was applied to search, collate, and analyse thousands of peer-reviewed, climate-focused publications to uncover scholarly evidence of the interlinkages between climate, socio-economic risks and insecurities, and conflict. This fact sheet summarises how these relationships have been documented, both at the global level and specifically for the selected countries. Overall, the analysis has found that while the literature is cognisant of the mechanisms by which climate exacerbates the risk for conflicts, there is still space for research that aims to disentangle the complexity of the climate security nexus.

Methods: leveraging on machine learning for evidence syntheses

The approach is based on the foundations of bibliometrics analysis, broadly defined as a set of quantitative methods to assess books, articles and other publications. More recently, the field has expanded beyond measuring the impact of academic outputs to include systematic, machine-driven thematic reviews (Aristovnik et al, 2020; Klingelhöfer et al, 2020; Porciello et al, 2020). This analysis draws upon such methodological innovations to explore relevant subjects through text mining and network analysis techniques.

The Scopus[1] database – one of the most comprehensive abstract and citation databases of peer-reviewed literature available – was queried to identify literature that broadly covered climate security in Africa: *(TITLE-ABS-KEY(climate)) AND ((security)) AND (Africa).* The query resulted in 19,162 publications between 1977-2021, of which 68% comprise journal articles, 12% comprise Reviews, 11% are book chapters, and the remaining 9% include other research outputs such as conference papers, letters, briefs, etc.

First, a country detection algorithm was devised to identify countries mentioned in the abstracts of the publications, as a measure of geographical distribution. Then, building on the country-level impact pathways developed for Kenya, Mali, Nigeria, Senegal, Sudan, Uganda and Zimbabwe, a taxonomy was constructed to establish broad categories and

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[1] www.scopus.com

specific topics for classification. The framework consists of a total of 115 terms, organised within seven groups of variables: Climate, Conflict, Agricultural impacts, Resources, Socioeconomic, Socioecological, Political/Institutional.

The terms were matched to AGROVOC[2], the Food and Agriculture Organisation's open- source, multilingual vocabulary. AGROVOC consists of more than 37,000 concepts covering FAO's areas of interest, such as food, nutrition, agriculture, fisheries, forestry, environment, etc. Vocabulary is available in up to 37 languages. For each topic, the corresponding AGROVOC definition was extracted, and a custom algorithm was developed to detect and classify the related terminology within the abstracts of the publications. The topics were then assessed through correlation measures and network analysis to identify the dynamics of linkages among them.

Main findings: global trends in climate security research

Figure 1 presents the distribution of publications by year. Reflective of the growing concern with the climate crisis in the scientific community and beyond, the last decade shows a major intensification of research activity.

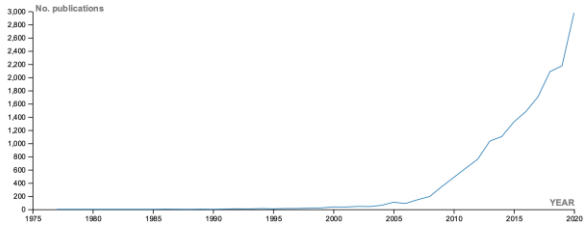

Figure 1 Timeline of publications extracted from Scopus.

The country detection algorithm identified that despite the query restriction for Africa, most of the research has also involved other countries such as China, India, and the UK. Climate Security Observatory countries are included in 1753 publications, as shown in Figure 1.

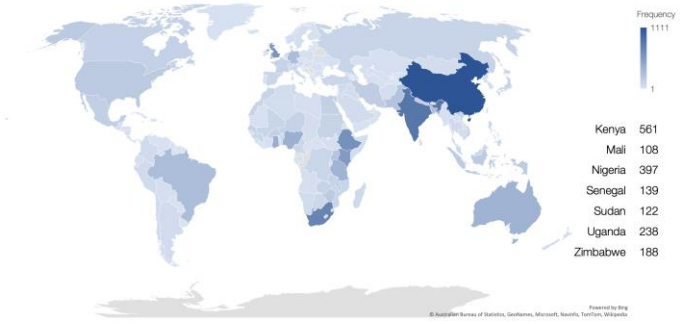

Figure 2 Geographic distribution of publications extracted from Scopus.

[2] https://agrovoc.fao.org

The custom algorithm to classify the seven categories and their respective variables was applied to the corpus containing the abstract of the publications. Figure 3 shows their overall distribution, as frequency counts. The resource variables 'Livestock' and 'Water' are the most frequently covered subjects in the dataset, followed by socioeconomic variables 'Poverty', 'Social structure'[3], 'Hunger' and 'Food security'. Considering the initial query in Scopus, these distributions characterise the types of conflict, the socioeconomic and ecologic insecurities, and the political factors contained in research about climate and security issues in Africa.

Figure 3 Distribution of topics identified in publications extracted from Scopus. More frequent terms represented by wider wedges in the pie chart.

While the overall distribution of topics can uncover the cumulative prominence of themes, a temporal distribution presents the evolution of topic prevalence over time. Figure 4 presents a timeline of publications covering different types of conflict. 'Armed conflict', 'War', 'Crime' and 'Theft' are the most prevalent conflict types throughout the period of analysis. The trends in these four cases are aligned with the overall increase in climate-focused research, indicating that concerns about the contributions of climate shocks to both long-term and immediate conflict threats have also intensified.

[3] The concept 'Social structure' captures the collective properties exhibited by social entities and identifies the characteristics of and the relationships among their component elements. Includes family structures, social groups, institutions, and networks (AGROVOC).

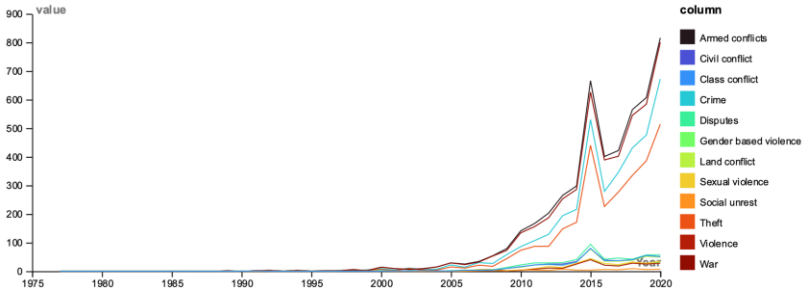

Figure 4 Timeline of publications extracted from Scopus that contain conflict variables.

To further unpack the interlinkages between different topics within the publications, a measure of correlation was established to identify when terms are present within the same body of text. A strong correlation indicates that the terms consistently occur within the same document. Figure 5 displays the 25 variables most correlated to conflict. Livestock and water resources are the most frequent co-occurrences, and, corroborating other research conducted by the CGIAR Climate Security Focus, temperature variability also presents a strong association. Such correlations signal that within the broader context of climate science in Africa, research on peace and security recognizes the complex pathways within which climate affects conflict.

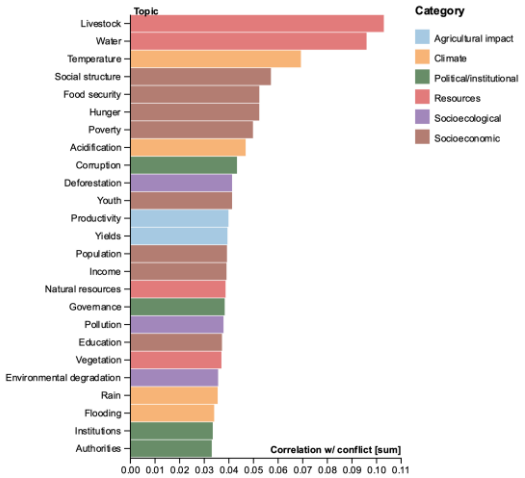

Figure 5 Top 25 correlations between conflict and other topics identified in the publications extracted from Scopus.

The direct links between climate and conflict are presented in Figure 6, which features the correlations among the four major conflict types and climate stressors and socioecological variables. Once again, temperature is strongly associated to ‘War’ and to ‘Armed conflicts’. Other important associations occur between ‘Flooding’ and ‘War’, and between ‘Deforestation’ and ‘Armed conflicts’.

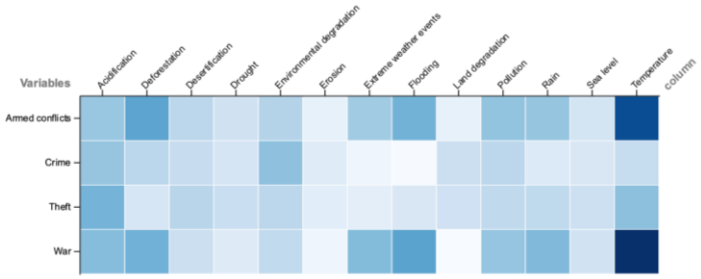

Figure 6 Correlations between conflict types and climate shocks identified in the publications extracted from Scopus.

Lastly, a network analysis enables the visualization of all interconnections between climate variabilities, socio-economic and conflict risks. As defined in the Climate Security Observatory's country level network analysis , a network is a graphical representation of the relationships (edges) between different entities (nodes). In this case, the publications and the topic variables are the nodes. Their relations comprise lines connecting pairs of nodes – here determined by the identification of topics in each publication. This means that a publication is "connected" to a topic or a country if associated words are present in the abstract[4].

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The analysis detected 6,119 publications that contained both climate and conflict topics, globally. The network shown in Figure 7 was restricted to this subset to accentuate the complexity of the relationships between climate variabilities, socio-economic insecurities, and conflict risks.

It is possible to see five coloured clusters. The biggest one is orange and encompasses 26% of the network. It is focused on major socioeconomic variables such as 'poverty', 'food security', 'hunger', and 'population', as well as the two largest agricultural impact nodes, 'Productivity' and 'Yields'. Climate stressors include 'Rain' and 'Drought', and conflict types within this community are 'Crime' and 'Theft'. The blue group (25% of the network) contains the most significant nodes: 'Livestock' and 'Water' resources, as well as to the two largest conflict types, 'Armed conflict' and 'War' are associated to 'Temperature', 'Flooding', 'Sea level rise', and 'Extreme weather events'. Topics within the purple cluster (21%) include the majority of land and resource-related variables, whereas the green cluster englobes various socioeconomic insecurities, political/ institutional variables, and with lesser occurring conflicts. Lastly, a small group in brown (8%) associates water access issues with corruption and with impacts on food prices and markets.

Besides the modularity clusters, the proximity of nodes in the graph also expresses communities that help interpret topic dynamics. For instance, the largest group of overlapping nodes shows that climate shocks ('Rain', 'Extreme weather events') are associated to socioeconomic insecurities ('Food security', 'Hunger', 'Poverty'), which are

[4] The spatialization of nodes was estimated with a force-directed algorithm that turns structural proximities into visual proximities (Jacomy et al., 2014). This means that linked nodes are drawn closer while unrelated nodes are pushed farther apart, thus facilitating interpretation of the data. The layout algorithm places each node depending on the other nodes, in a process that depends on the connections between them, thus creating groups, or 'communities' of nodes. To further explore these dynamics, a modularity algorithm (Blondel et al., 2008) was applied to identify clusters of nodes that are more densely connected together than to the rest of the network, and these were coloured accordingly. The sizes of the nodes and the labels are partitioned by in-degree centrality, a measure of the number of connections to a particular node.

linked to resources (‘Livestock’, ‘Water’) that are then linked to conflict risks (‘Armed conflict’, ‘War’). While such a visualization does not attempt to establish direction or causation, these close associations are reflective of the interactions among them, as recognised in scientific literature.

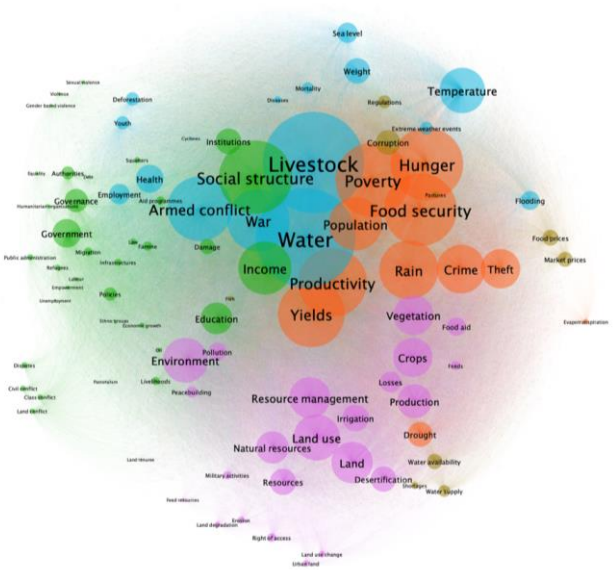
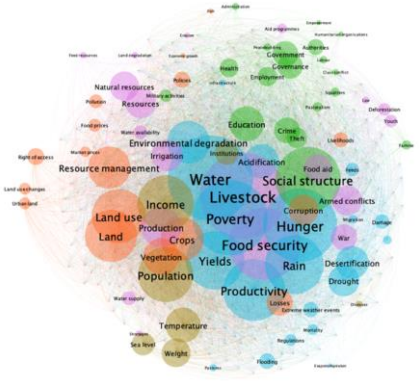


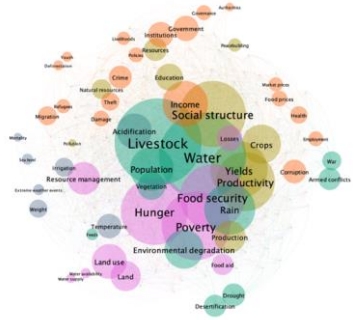
Figure 7 Network visualisation of climate variabilities, socio-economic insecurities, and conflict risks detected in publications extracted from Scopus. Force-directed graph, with node size partitioned by weighed in-degree, coloured by modularity class (in-degree ≥ 10).

The Climate Security Observatory: data-driven impact pathways

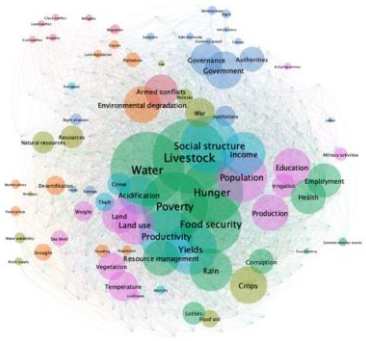
The country detection algorithm enabled the compilation of subsets of publications that specifically covered the countries in the Climate Security Observatory. Focusing on seven African countries, it is possible to see variations in the distribution and dynamics of variables, highlighting the context-dependent nature of the climate-security nexus.



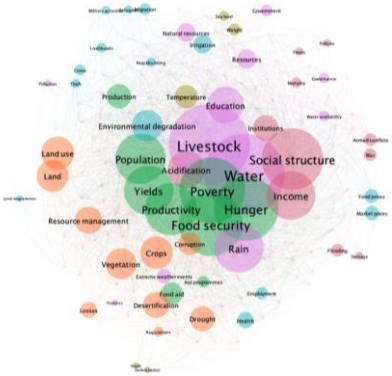
Kenya
The blue cluster contains the central node ‘Water’ and groups several climate stressors (e.g. Rain), socio-ecological variables (Environmental degradation), agricultural impact variables (Productivity) and socio-economic insecurities (Poverty). Conflict variables are present in the green cluster, but the two major ones, ‘Armed conflict’ and ‘War’, are placed in a pink group connected to Livestock and Food security.



Mali
‘Livestock’ and ‘Water’ are closely connected in this network. Their group also includes climate stressors ‘Rain’, and ‘Drought’, and conflict variables ‘Armed conflicts’ and ‘War’. The centre of the graph also evidences other important linkages with socioeconomic variables such as ‘Food security’, ‘Hunger’ and ‘Poverty’, as well as with agricultural impact variables (Yields, Productivity).

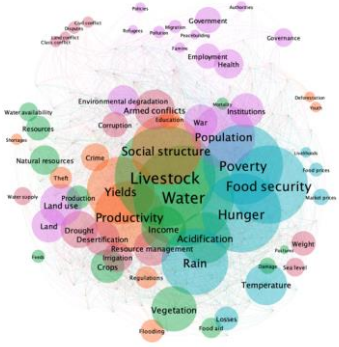


Nigeria
Rainfall variability and water availability are once again connected to ‘Livestock’, ‘Poverty’, and ‘Food security’. Though ‘Armed conflicts’ and ‘Degradation’ are different coloured groups, they appear in close proximity, indicating an association between them in the literature.



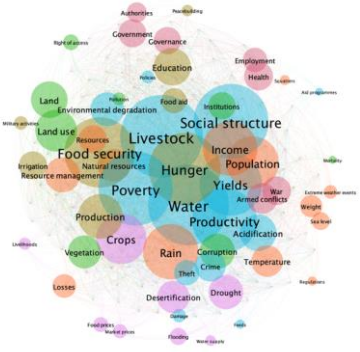
Senegal

As the most peaceful country in the Sahel, conflict variables are neither central, nor prevalent. The large central group of nodes connects ‘Rain’ and ‘Acidification’ to various socioeconomic, agricultural, and political variables, as well as to ‘Livestock’ and ‘Water’ resources.



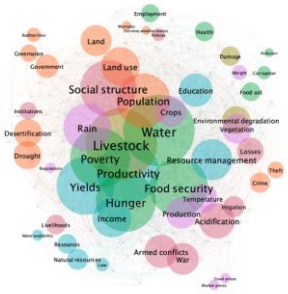
Sudan

The proximity between nodes in this network illustrates the complexity of Sudan’s social, economic and ecological vulnerabilities. Rainfall and temperature variabilities are linked to ‘Hunger’, ‘Food security’ and ‘Poverty’. ‘Livestock’ and ‘Water’ are once again central nodes. Conflict variables are grouped in the same colour cluster as ‘Drought’ and ‘Desertification’. ‘Armed conflicts is also in proximity to ‘Environmental degradation’.



Uganda

‘Hunger’ is the central node in this network and is surrounded by other major nodes grouped into the blue cluster (‘Livestock’, ‘Social structure’, ‘Poverty’, ‘Water’, ‘Productivity’, ‘Yields’). ‘War’ and ‘Armed conflicts’ are the two main conflict types detected and appear in the same coloured cluster as political variables ‘Government’, ‘Governance’ and ‘Authorities’, as well as socioeconomic variables ‘Employment’ and ‘Health’.



Zimbabwe
'Livestock' and 'Water' are the main resources identified in the literature. Soil acidification is located within the same coloured cluster as 'Irrigation', 'Losses' and 'Livelihoods', as well as the two most prevalent conflict types ('Armed conflicts' and 'War'). 'Rain' and 'Temperature' are both close to the green cluster of socioeconomic variables.

External references

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